

## A SCIENTOMETRIC STUDY OF NANOCOMPOSITES: A GLOBAL PERSPECTIVE

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### ABSTRACT

The study examines Nano composites publications retrieved from Web of Science (WoS) for the period 1999 - 2012. A total of 42,876 papers were published and 7,78,957 citations were received. The outcomes of the study are: China produced highest number of papers (11,561) and USA received highest number of citations (2,40,589); South Korea was received highest (46.09%) Average Citation per Paper (ACP); the study uses different indicators, sources preferred, authors contribution, the Average Growth Rate (AGR), the Activity Index (AI), the Attractive Index (AAI) and the Publication Efficiency Index (PeI) to analyze the aspects of the publications.

**KEYWORDS:** Nanocomposites, Nanomaterials, Nanoscale, Relative Indicators, Scientometrics

### INTRODUCTION

Materials made with nano scale components are adding new dimensions to composite materials and major improvements in functional and structural properties are within reach. Such Nano composites are of great importance which are used in automotive, aerospace, consumer products and mechanical engineering (Nano composite, 2005).

Nanocomposites are diversiform solid material where one of the segments has one, two or three proportions of less than 100 nanometers (nm), or structures having nano-scale repeat distances between the different phases that make up the material (Ajayan et al., 2004).

The advancement in Nanocomposites is mottled and covers many manufacturing and production units. Nanocomposites are made with a multiplicity of superior physical, thermal and other exclusive properties. The materials are needed to meet an extensive variety of energy proficient applications with light weight, high mechanical strength, unique color, electrical properties and high reliability in extreme environments (Masia, 2008). To assess the potential value of Nanocomposites, it is important to determine which Nanomaterials can be effectively integrated into Nanocomposites and what new or improved properties this enables. Once the basic models of this are developed, it will be important to determine how the mixing of multiple Nanomaterials in a polymer affects the resulting structure and properties of the Nanocomposite. One Nanocomposite may be required to improve the mechanical property, and another may be required to change the electrical properties; however the addition of the electrical material may also change the mechanical properties of the Nanocomposite through interactions with the polymer and Nanoparticles (Masia, 2008).

### OBJECTIVES OF THE STUDY

The main objective of the study is to analyze the publication growth and to make quantitative assessment of world's Nanocomposites research.

The specific objectives of the study are to

- Know the annual growth of Publications;
- Find out Average Growth Rate of Nanocomposites research;
- Study the geographical distribution of research output in the field of Nanocomposites;
- Identify most prolific authors in the field of Nanocomposites;
- Apply activity index, attractive index and publication efficiency indices;
- Identify highly productive institutions in the world scenario;
- Study different sources of publications;
- Know the language wise distribution of papers; and
- Apply and use different indices for Nanocomposites research.

## METHODOLOGY

The data has been collected from the Thomson Reuter's Web of Science (WoS) Science Citation database. The data is retrieved on 11<sup>th</sup> December, 2013. The string used to retrieve the data on Nanocomposites research during 1999-2012 is as follows:

**TS= (Nanocomposites) AND PY= (1999-2012)**

The  $R^2$  value can be mathematically derived from the below formula;

$$R^2 = 1 - \frac{SSE}{SS_{yy}}$$

$R^2$  is the coefficient of determination that shows the relation between dependent variable and the other independent variables.

The Activity Index (AI) is an indicator, which compares a country's research performance with that of the world (Chen and Guan 2011; Hu and Rousseau 2009). The Activity Index is a relative performance indicator, which takes into account the effect of the publications size of the evaluated country in the Nanocomposites literature.

Mathematically, the Activity Index ( $AI_i^t$ ) for the  $i^{\text{th}}$  country in the  $t^{\text{th}}$  year during the given period can be defined as follows:

$$AI_i^t = \frac{\left( P_i^t / \sum P \right)}{\left( TP^t / \sum TP \right)}$$

$P_i^t$  is the Nanocomposites publication by the  $i^{\text{th}}$  country in the  $t^{\text{th}}$  year;  $\sum P$  is the Nanocomposites publications by the  $i^{\text{th}}$  country during the given publication period;  $TP^t$  is the total Nanocomposites publications by the world in the  $t^{\text{th}}$  year;  $\sum TP$  is the total Nanocomposites publications by the world during the given publication period. If  $AI=1$ , it indicates that

the country's research effort in a particular field corresponds precisely to the world's average. If  $AI > 1$ , it can be said that the country spends more energy and money to the given field than the world average, or if  $AI < 1$  (Hu and Rousseau 2009; Chen and Guan 2011).

The Attractive Index (AAI) is an indicator that is used to characterize the relative impact of a country's publications in a given field as reflected by the citations they received during a given period (Chen and Guan 2011; Hu and Rousseau 2009). Mathematically, the Attractive Index ( $AAI_i^t$ ) for the  $i^{\text{th}}$  country in the  $t^{\text{th}}$  year during the given period can be defined as follows:

$$AAI_i^t = \frac{\left( C_i^t / \sum C \right)}{\left( TC^t / \sum TC \right)}$$

$C_i^t$  is the *Nanocomposites publications* citations by the  $i^{\text{th}}$  country in the  $t^{\text{th}}$  year;  $\sum C$  is the *Nanocomposites* research citation by the  $i^{\text{th}}$  country during the given citation period;  $TC^t$  is the total *Nanocomposites* citations by the world in the  $t^{\text{th}}$  year;  $\sum TC$  is the total *Nanocomposites* citations by the world during the given citation period. If  $AAI = 1$ , indicates that the country's relative citation impact in the given field corresponds precisely to the world average. If  $AAI > 1$ , indicates that the country's relative citation impact in that field is higher than the world average and if  $AAI < 1$ , indicates that the country's relative citation impact in the field is lower than the world average (Hu and Rousseau 2009; Chen and Guan 2011).

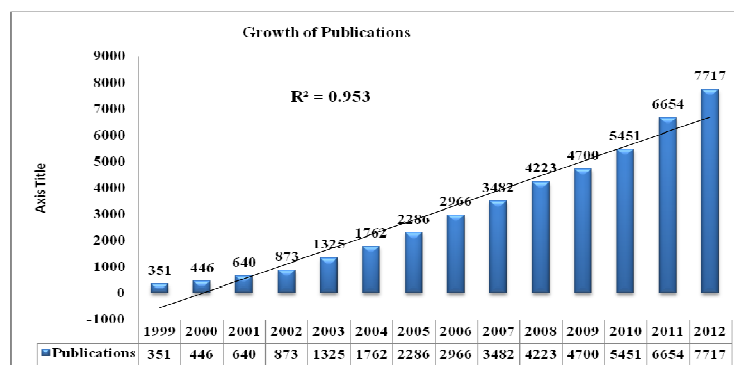
The Publication Efficiency Index (PEI) is an indicator that determines if the impact of research publications by the top-10 contributing countries in *Nanocomposites research* corresponds with the country's research efforts during the period 1999-2012. Mathematically, the publication efficiency index ( $PEI_i^t$ ) for the  $i^{\text{th}}$  country in the  $t^{\text{th}}$  year during the given period can be defined as follows:

$$PEI_i^t = \frac{\left( C_i^{t+2} / \sum C \right)}{\left( P_i^t / \sum P \right)}$$

$C_i^{t+2}$  is the citations by the  $i^{\text{th}}$  country, y in the  $(t + 2)^{\text{th}}$  year;  $\sum C$  is the citations by the  $i^{\text{th}}$  country during the given citation period;  $P_i^t$  is the publications by the  $i^{\text{th}}$  country in the  $t^{\text{th}}$  year;  $\sum P$  is the publications by the  $i^{\text{th}}$  country during the given publication period. It is obtained through dividing the percentage of citations "returns" by the percentage of publications "efforts". If  $PEI > 1$ , this indicates that the impact of publications in a given field by a particular country is more than the research effort devoted to it during the period considered.

## RESULTS AND DISCUSSIONS

The total number of publications in the field of Nanocomposites is 42,876 during the mentioned period (1999-2012) as reflected in Web of Science database. The total number of citations received for Nanocomposites research during 1999-2012 were 7,78,957. During the period, the exponential growth pattern was reflected by the value of  $R^2$  from WoS ( $R^2 = 0.953$ ) and Correlation Coefficient is 0.9763. The result confirms the fast growth of publications in Nanocomposites research during the period 1999-2012.



**Figure 1: Growth of Publication and Citations in Nanocomposites Research (1999-2012)**

### Publications and Citations Trend of Different Countries

Table 1 shows the publications output of top 19 countries which have contributed at least 1% of the total publications. Among the different countries, China topped the list with 11,561 publications and its share is 26.964 % of the total publications in the field of Nanocomposites. The USA ranked second in terms of number of publications (8,254) but received the highest citations (2,40,589) with 29.15 Average Citation per Paper (ACP) and with 186 H-index (which is highest among the countries). India has 3047 publications to its credit, whereas, South Korea with 2976 and Japan with 2209 publications ranked third to fifth respectively. It is surprising to note that though the publications output of some countries are less but their ACP is high compared to that of top countries producing number of publications. South Korea has highest ACP with 46.09, Singapore with 31.86, USA with 29.15, Canada with 24.79, and Germany with 24.57 and Australia with 24.31 ranked first to sixth respectively. Among the H-index, USA topped the list with 186 (though its rank is second in terms of number of publications), followed by China with H-index 123, Germany with H-index 99, Japan with 93 and France with H-index 90 ranked second to fifth respectively.

**Table 1: Performance of the Top Countries**

Sl. No	Countries	Total Publications	Total Citations	Average Citations Per Publication	H-Index	Percentage
1	China	11,561	1,79,374	15.51	123	26.964
2	USA	8,254	2,40,589	29.15	186	19.249
3	India	3,047	33,925	11.14	64	7.107
4	South Korea	2,976	47,872	46.09	87	6.941
5	Japan	2,209	47,114	21.33	93	5.152
6	Germany	2,188	53,619	24.51	99	5.103
7	France	1,981	43,901	22.46	90	4.620
8	Italy	1,514	26,395	17.43	71	3.531
9	Taiwan	1,433	24,792	17.3	69	3.342
11	Spain	1,302	21,158	16.25	61	3.037
11	UK	1,138	25,576	22.47	74	2.654
12	Iran	1,128	6,909	6.12	28	2.631
13	Russia	1,122	7,229	6.44	32	2.617
14	Canada	1,028	25,488	24.79	68	2.398
15	Brazil	838	9,599	11.45	42	1.954
16	Australia	810	19,694	24.31	66	1.889
17	Singapore	723	23,032	31.86	72	1.686
18	Poland	697	6,835	9.81	36	1.626
19	Turkey	470	5,208	11.08	34	1.096

(1% and above contribution of total publications)

### Growth Rate of Publications in the Field of Nanocomposites

The table 2 shows that the total of 42,876 publications were published during the period (1999-2012) which received 7, 78,957 citations. The highest numbers of publications i.e. 7,717 were published in 2012. The highest number of citations were received i.e. 83,008 for the year 2007. It appears that the annual growth during the period is consistent. There is a gradual and exponential Growth Rate during 2000 to 2006. The Annual Growth Rate is fluctuant during 2007 to 2012. The quantity and quality of research always go hand in hand as average citations per year are decreasing. The older publications were received more citations than the publications published recently (Kademani, et al., 2011). During 2005 to 2006 highest citations were received. After 2008, there is a decline in receiving the number of citations.

**Table 2: Growth Rate of Publications in the Field of Nanocomposites**

Publications Year	Publications	Annual Growth Rate (%)	Total Citations	Average Citations Per Paper
1999	351	----	19,114	54.46
2000	446	+27.07	22,997	51.56
2001	640	+43.50	43,480	67.94
2002	873	+36.41	42,369	48.53
2003	1325	+51.78	60,927	45.98
2004	1762	+32.98	60,006	34.06
2005	2286	+29.74	76,729	33.56
2006	2966	+29.75	77,455	26.11
2007	3482	+17.40	83,008	23.84
2008	4223	+21.28	75,561	17.89
2009	4700	+11.30	71,479	15.29
2010	5451	+15.98	68,630	12.59
2011	6654	+22.07	50,822	7.64
2012	7717	+15.98	26,380	3.42
<b>Total Citations</b>	<b>7,78,957</b>			

### Activity Index (AI)

The Republic of China has produced highest publications (11,561) and received 1,79,374 citations (Average citations per publication is 15.51), followed by the USA which has produced 8254 publications and received highest number of citations (2,40,589), with 29.15 Average Citations per Publications. Table 3 gives the Activity Index of different countries in Nanocomposites research. Japan placed fifth position in terms of publications and has highest mean AI i.e. 1.37, followed by the USA (1.23 AI), Germany (1.13), South Korea and Taiwan (1.02 respectively) and France (1) ranked second to sixth respectively. This indicates that all these countries' Average AI is greater than 1 ( $AI > 1$ ) indicating an active and specialized focus on Nanocomposites research. Among other countries, Italy, Spain, China and India's average AI is less than 1 means not corresponding to the world's average.

**Table 3: Activity Index (AI) of Top Ten Countries Researching on Nanocomposites**

Years	China	USA	India	South Korea	Japan	Germany	France	Italy	Taiwan	Spain
1999	0.43	1.58	0.68	0.57	3.04	1.34	1.73	0.81	0.77	0.84
2000	0.48	1.55	0.50	0.87	1.87	1.63	1.65	0.44	0.60	0.96
2001	0.57	1.75	0.53	1.40	1.91	1.26	1.25	0.93	0.84	0.72
2002	0.66	1.57	0.44	1.14	1.49	1.26	1.51	1.14	0.93	0.38
2003	0.76	1.47	0.56	1.26	1.63	1.23	1.08	0.92	1.24	0.89
2004	0.79	1.38	0.61	1.15	1.56	1.06	1.15	1.17	1.38	0.47
2005	0.83	1.36	0.58	1.06	1.15	1.13	1.39	1.00	1.44	0.66
2006	0.96	1.11	0.88	0.91	1.34	1.00	1.03	1.15	1.34	0.79
2007	0.95	1.11	0.91	0.94	1.04	1.11	1.04	0.93	1.10	0.97

Table 3: Contd.,

2008	0.96	1.05	0.94	0.94	0.96	0.98	1.04	1.04	1.32	1.12
2009	1.04	0.96	0.97	1.03	0.94	1.08	0.98	1.05	0.96	1.30
2010	1.03	0.87	1.20	1.04	0.89	0.99	0.90	0.88	0.87	1.14
2011	1.11	0.76	1.24	0.95	0.75	0.90	0.89	1.07	0.86	1.04
2012	1.19	0.74	1.23	0.97	0.65	0.82	0.82	0.95	0.68	1.05
<b>Mean</b>	0.84	1.23	0.80	1.02	1.37	1.13	1	0.96	1.02	0.88

### Attractive Index (AAI)

Table 4 indicates the Attractive Index of top ten countries. The USA, Japan, Germany and France recorded Attractive Index greater than 1 during 1999 to 2012. The relative citations impact in Nanocomposites research surpass the world's average. Whereas, China, India, South Korea, Italy, Taiwan and Spain recorded less than 1 Attractive Index, which is not corresponding to the world's average.

The AAI of China and India are constantly increasing during 2006 to 2012, seems to be performing better than other countries. The AAI of USA, South Korea, Italy and Spain are fluctuant trend, whereas, Japan, Germany, France and Taiwan AAI is decreasing during 2006 to 2012.

Table 4: Attractive Index (AAI) Top Ten Countries Researching on Nanocomposites

Years	Citations Per Year	China	USA	India	South Korea	Japan	Germany	France	Italy	Taiwan	Spain
1999	19,114	0.35	1.46	0.50	0.59	1.13	1.83	1.30	0.59	0.97	0.67
2000	22,997	0.36	1.06	1.01	0.58	1.23	0.95	1.21	0.67	1.01	0.83
2001	43,480	0.42	1.58	0.82	1.10	1.18	1.27	1.20	0.92	0.93	0.32
2002	42,369	0.60	1.44	0.46	1.38	1.46	1.17	1.25	0.93	0.81	0.32
2003	60,927	0.79	1.05	0.57	1.12	2.24	0.91	0.80	0.75	1.19	1.17
2004	60,006	0.81	1.14	0.73	0.94	1.37	1.05	1.12	1.17	1.23	0.53
2005	76,729	0.79	1.04	0.65	1.15	0.78	1.37	1.67	1.17	0.97	1.09
2006	77,455	1.03	0.88	1.05	0.82	0.97	1.01	0.82	1.21	1.23	0.87
2007	83,008	1.01	1.01	1.26	0.80	0.69	0.88	0.79	0.99	1.16	1.18
2008	75,561	1.08	0.88	1.24	0.94	0.79	0.84	1.04	1.20	1.08	1.27
2009	71,479	1.31	0.83	1.24	1.00	0.88	0.87	0.82	1.01	0.77	1.34
2010	68,630	1.41	0.79	1.22	1.13	0.63	0.89	0.85	0.77	0.71	1.32
2011	50,822	1.56	0.70	1.43	1.11	0.52	0.77	0.73	0.98	0.92	1.07
2012	26,380	1.81	0.64	1.46	1.11	0.50	0.63	0.58	0.96	0.66	1.17
<b>Total</b>	7,78,957	0.95	1	0.97	0.98	1.03	1.03	1.01	0.95	0.97	0.94
<b>Mean</b>											

### Publication Efficiency Index (PEI)

The results demonstrate that the impact of research publications in *Nanocomposites* by all the countries except India's PEI score is greater than 1 ( $PEI > 1$ ). This means that for those nine countries, the research performance is more than the research effort devoted to it during 1999 - 2012. Taiwan and Italy were highest PEI score with 1.84 and 1.75 respectively in the Nanocomposites research.

The remaining seven countries' PEI score is greater than one since 1999 but these countries' PEI score is lesser than 1 in the recent years. Japan displays good performance during 2007 to 2012 and recorded the highest score of PEI, i.e. 6.92 in a single year (2012). All ten countries seem to display regular fluctuant trends during the study period 1999-2012.

**Table 5: Publication Efficiency Index (PEI) of Top Ten Countries**

Year	Publications	Citations	China	USA	India	South Korea	Japan	Germany	France	Italy	Taiwan	Spain
1999	351	19,114	2.41	2.77	0.45	0.19	0.90	4.09	2.26	2.20	3.79	2.38
2000	446	22,997	2.15	1.95	0.18	0.31	0.54	1.66	2.08	4.26	4.74	2.45
2001	640	43,480	2.71	3.38	0.17	0.37	0.43	3.78	3.57	3.69	4.13	1.66
2002	873	42,369	2.41	2.44	0.36	0.43	0.38	2.49	2.21	2.20	2.34	2.28
2003	1,325	60,927	2.64	1.80	0.39	0.50	0.29	1.87	1.88	2.06	2.43	3.31
2004	1,762	60,006	1.94	1.55	0.45	0.62	0.61	1.87	1.81	1.87	1.68	2.14
2005	2,286	76,729	1.76	1.41	0.48	0.57	0.80	2.24	2.22	2.15	1.25	3.03
2006	2,966	77,455	1.55	1.14	0.58	0.63	0.97	1.45	1.15	1.51	1.32	1.58
2007	3,482	83,008	1.39	1.19	0.55	0.71	1.16	1.04	1.00	1.41	1.39	1.59
2008	4,223	75,561	1.11	0.83	0.77	0.96	1.23	0.84	0.99	1.14	0.80	1.12
2009	4,700	71,479	1.05	0.72	0.93	1.23	1.28	0.68	0.70	0.80	0.67	0.86
2010	5,451	68,630	0.96	0.63	1.41	1.51	2.03	0.62	0.66	0.61	0.57	0.80
2011	6,654	50,822	0.59	0.39	2.05	2.27	3.41	0.36	0.34	0.39	0.45	0.43
2012	7,717	26,380	0.29	0.16	4.49	5.14	6.92	0.15	0.13	0.19	0.18	0.21
<b>Total</b>	4,2876	7,78,957										
<b>Mean</b>			1.64	1.46	0.95	1.10	1.50	1.65	1.50	1.75	1.84	1.70

### Language-Wise Distribution of Publications

Table 6 depicts the language –wise distribution of publications. Scientists have contributed more predominantly in English language than any other languages. Among the languages, English leads with (41,859) 97.63% of total publications, followed by Chinese with 1.39%. The total publications have been scattered in 21 different languages in the field of Nanocomposites research during 1999-2012.

**Table 6: Language Wise Distribution of Publications**

Sl. No	Languages	Publications	Percentage
1	English	41,859	97.63
2	Chinese	596	1.392
3	Korean	110	0.257
4	Polish	91	0.212
5	Portuguese	62	0.145
6	Japanese	44	0.103
7	German	26	0.061
8	Spanish	25	0.058
9	French	15	0.035
10	Russian	15	0.035
11	Romanian	7	0.016
12	Ukrainian	7	0.016
13	Czech	6	0.014
14	Serbo Croatian	5	0.012
15	Croatian	2	0.005
16	Estonian	1	0.002
17	Finnish	1	0.002
18	Hungarian	1	0.002
19	Malay	1	0.002
20	Serbian	1	0.002
21	Slovak	1	0.002

### Prolific Authors in Nanocomposites Research

A total of 62,927 authors contributed to the 42,876 papers in WoS during the period 1999-2012. The ratio of number of articles is 62,927:42,876 or 1: 0.68. Table 7 shows the most productive (31) authors with their respective authorship score (greater than or equals to 100) in the field of Nanocomposites. All the 31 most productive authors contribute on an average of 10.34% of total publications during the period. Zhang, Y. (China) has the highest publications

(242 publications), followed by Wang, Y (China) has 236 Publications. It is also revealed from the study of among the top 31 authors, 22 authors belong to China, which is predominantly high compared to other countries, followed by four authors belong to South Korea, two authors belong to the USA and One author belongs to India, Belgium and UK respectively.

**Table 7: Prolific Authors in the Field of Nanocomposites**

Sl. No	Authors	Country	Publications	Percentage
1	Zhang Y	China	242	0.564
2	Wang Y	China	236	0.55
3	Liu Y	China	195	0.455
4	Wang X	China	194	0.452
5	Li J	China	189	0.441
6	Zhang J	China	186	0.434
7	Li Y	USA	183	0.427
8	Hu Y	China	174	0.406
9	Wang L	China	172	0.401
10	Choi HJ	South Korea	147	0.343
11	Chen L	China	145	0.338
12	Wang J	China	144	0.336
13	Wilkie CA	USA	136	0.317
14	Zhang I	China	136	0.317
15	Bhowmick AK	India	130	0.303
16	Song L	China	130	0.303
17	Liu L	China	124	0.289
18	Lee JH	South Korea	122	0.285
19	Liu J	China	122	0.285
20	Chen Y	China	117	0.273
21	Zhang LQ	China	116	0.271
22	Zhang Q	China	116	0.271
23	Li L	China	115	0.268
24	Zhang H	China	115	0.268
25	Dubois P	Belgium	114	0.266
26	Kim J	South Korea	114	0.266
27	Wang Q	China	109	0.254
28	Wang K	China	103	0.24
29	Yang J	China	103	0.24
30	Kim JK	South Korea	102	0.238
31	Yang Y	China	102	0.238

### Organizations Productivity

Table 8 represents the list of 26 Institutions which have contributed at least  $\geq 0.5\%$  of total publications on Nanocomposites during 1999–2012. The total publications count of top twenty six institutions is 10,163 (24.73%). Chinese Academy of Science, Zhejiang (China) has the highest publications (1839) among the different organizations, followed by Russian Academy of Science, Moscow (Russia) has 656 publications, University of Science and Technology, Anhui (China) with 526 publications, Beijing University of Chemical Technology, Beijing (China) with 477 publications and Shanghai Jiao Tong University, Shanghai (476) publications ranked second to fifth respectively. The study reveals that the organizations from China dominate among the other organizations (top 26 organizations) considered for the study, followed by four organizations from South Korea, two organizations from India, Singapore, the USA and one organization from Italy, Russia, and Spain appeared in the list of top twenty six organizations in the field of Nanocomposites.



**Table 8: Organization wise Distributions of Publications**

Sl. No	Organizations	Country	Publications	Percentage
1	Chinese Academy of Sciences, Beijing	China	1,839	4.289
2	Russian Academy of Science, Moscow	Russia	656	1.53
3	University of Science and Technology, Hong Kong	China	526	1.227
4	Beijing University of Chemical Technology, Beijing	China	477	1.113
5	Shanghai Jiao Tong University, Shanghai	China	476	1.11
6	Sichuan University, Sichuan	China	458	1.068
7	Consejo Superior de Investigaciones Cientificas (CSIC), Madrid	Spain	434	1.012
8	Fudan University, Shanghai	China	419	0.977
9	Indian Institute of Technology IIT Kharagpur	India	403	0.935
10	Zhejiang University, Zhejiang	China	374	0.872
11	Jilin University, Jilin	China	319	0.744
12	National University of Singapore, Singapore	Singapore	316	0.737
13	Inha University, Incheon	South Korea	306	0.714
14	Nanjing University, Gulou	China	295	0.688
15	South China University Technology, Guangdong	China	293	0.683
16	Nanyang Technology University, Nanyang Avenue	Singapore	289	0.674
17	Seoul National University, Seoul	South Korea	273	0.637
18	Tsinghua University, Haidian	China	267	0.623
19	Georgia Institute of Technology, Atlanta, GA	USA	248	0.578
20	Consiglio Nazionale delle Ricerche (CNR), Roma	Italy	246	0.574
21	Hanyang University, Seoul	South Korea	242	0.564
22	Centre national de la recherche scientifique (CNRS), Paris	France	233	0.543
23	Harbin Institute Technology, Heilongjiang	China	224	0.522
24	Korea Advance Institute of Science And Technology, Daejeon	South Korea	222	0.518
25	Indian Association of Cultivation science, Jadavpur	India	219	0.511
26	United States Air Force (USAF), The Pentagon	USA	215	0.501

### Preferred Sources of Publications

The distribution of Nanocomposites publications were spread over 1,590 sources of publications. The table 9 shows top 41 journals which have produced publications > 0.5% of total publications during the period 1999 to 2012. *Journal of Applied Polymer Science* (USA) has 2494 publications and topped the list, followed by *Polymer* (UK) with 1302 publications, *Journal of Materials Chemistry* (UK) with 1018 publications, Abstract Paper of the American *Chemical Society* (USA) with 1006 publications and *Journal of Nanoscience and Nanotechnology* (USA) with 741 publications topped the list and ranked second to fifth respectively. The study also reveals that among the 41 sources of publications, 20 journals are published form USA, ten from UK, four from Netherlands and Switzerland respectively and 3 from Germany.

**Table 9: Preferred Sources of Publications**

Sl. No	Source Titles	Country	Publications	Percentage
1	Journal of Applied Polymer Science	USA	2494	5.817
2	Polymer	UK	1302	3.037
3	Journal of Materials Chemistry	UK	1018	2.374
4	Abstracts of Papers of the American Chemical Society	USA	1006	2.346
5	Journal of Nanoscience and Nanotechnology	USA	741	1.728
6	Macromolecules	USA	691	1.612
7	Composites Science and Technology	UK	685	1.598
8	Materials Letters	Netherlands	658	1.535
9	Journal of Polymer Science Part Polymer Physics	USA	579	1.35

Table 9: Contd.,

10	Chemistry of Materials	USA	564	1.315
11	Journal of Physical Chemistry	USA	563	1.313
12	Journal of Materials Science	USA	527	1.229
13	Polymer Engineering and Science	USA	515	1.201
14	Polymer Composites	USA	509	1.187
15	Polymer Degradation and Stability	UK	493	1.15
16	Langmuir	USA	448	1.045
17	Nanotechnology	UK	430	1.003
18	European Polymer Journal	UK	416	0.97
19	Journal of Applied Physics	USA	411	0.959
20	Applied Physics Letters	USA	373	0.87
21	Journal of Alloys and Compounds	Switzerland	367	0.856
22	Materials Chemistry and Physics	Switzerland	355	0.828
23	Materials Science and Engineering a Structural Materials Properties Microstructure and Processing	Switzerland	350	0.816
24	Polymer International	USA	347	0.809
25	Journal of Colloid and Interface Science	USA	343	0.8
26	Polymers for Advanced Technologies	USA	332	0.774
27	Journal of polymer Science part a Polymer Chemistry	USA	325	0.758
28	Macromolecular Materials and Engineering	Germany	313	0.73
29	Carbon	UK	289	0.674
30	Advanced Materials	Germany	277	0.646
31	Applied Surface Science	Netherlands	277	0.646
32	Composites Part a Applied Science and Manufacturing	UK	275	0.641
33	Journal of the European Ceramic Society	UK	269	0.627
34	ACS Applied Materials Interfaces	USA	263	0.613
35	Journal of Physical Chemistry	USA	262	0.611
36	Applied Clay Science	Netherland	248	0.578
37	Macromolecular Rapid Communications	Germany	244	0.569
38	polymer Plastics Technology And Engineering	USA	244	0.569
39	synthetic Metals	Switzerland	234	0.546
40	Carbohydrate Polymers	UK	226	0.527
41	Journal of Nanoparticle Research	Netherlands	222	0.518

( $\geq 0.5\%$  of Total Publications)

## CONCLUSIONS

The main objective of the study is to analyze the publication growth and to make quantitative assessment of the world's Nanocomposites research by collecting data from Web of Science (WoS) for the period 1999-2012. There is a consistent growth rate for the Nanocomposites research. China topped the list with 11,561 publications, where as USA has received highest citations, i.e. 2, 40,589 for 8,254 publications. The study reveals that USA, South Korea, Japan, Germany, France and Taiwan have AI greater than one. The relative citations impact in Nanocomposites research surpasses the world's average. The impact of research publications in Nanocomposites by all the countries' (except India) Publication Efficiency Index (PEI) is greater than 1. A total of 62,927 authors contribute 42,876 papers in Web of Science. Zhang, Y. from China has published highest i.e. 242 papers among the prolific authors.

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